AUSTROADS TEST METHOD AG:AM/T007

PAVEMENT DEFLECTION MEASUREMENT WITH A DEFLECTOGRAPH

1 SCOPE

This test method defines the procedure for measuring the maximum deflection and curvature of road pavements using a deflectograph.

Specific deflectograph machines may be known by proprietary names (e.g. the VicRoads designed deflectograph is known as the Pavement Strength Evaluator (PaSE)).

The structural capacity of a pavement is evaluated by measuring the deflections of a pavement under a standard load applied on a single axle through dual rear wheels (refer 4.1(b)). Testing is carried out at intervals of between 3 m to 7 m with measurements occurring simultaneously in both wheelpaths at a continuous speed up to 4 km/h.

The procedure contained in Austroads Test Method AG:AM/T008 can be followed to undertake validation and repeatability of measurement checks for deflectograph equipment. The test method has not, however, been verified by field experience, and engineering judgement should be exercised when considering and acting upon the results obtained.

This test method does not address all occupational health and safety issues associated with its use. It is the responsibility of the user to operate in accordance with appropriate legislation.

Deflectograph testing requires adequate traffic control. The traffic control required for this test should be based on the relevant Australian Standard (AS 1742 Part 3-2002).

The values measured represent the deflections of a pavement as obtained with the equipment and procedures stated herein. They do not necessarily agree or correlate directly with those obtained by other pavement deflection measuring methods.

2 REFERENCED DOCUMENTS

Austroads Test Method AG:AM/T008,*Validation and repeatability checks for a deflectograph*, March 2011.

International Organization for Standardization (ISO) 2007, International vocabulary of metrology – basic and general concepts and associated terms (VIM), ISO/IEC Guide 99, 3rd edn.

International Organization for Standardization (ISO) 2005, *Quality management systems – fundamentals and vocabulary*, ISO 9000:2005.

Standards Australia 2009, AS 1742.3:2009, *Manual of uniform traffic control devices – Traffic control for works on roads*. (Standards Australia: Sydney).

3 DEFINITIONS

(a) Deflection

The measured vertical elastic deformation of a pavement surface beneath the dual wheels of a standard axle load (refer 4.1(b)). Deflection is an indication of the rate at which permanent deformation will occur under traffic over time.

(b) Deflection bowl

A representation of the shape of the elastic deformation of the pavement surface caused by a load being applied to it (refer Figure 3.1). Deflectographs measure the 'loading' bowl, i.e. the load is moved towards the point at which the deflection is measured.

(c) Maximum deflection (D_0)

The measured maximum vertical movement of the pavement under load.

(d) Curvature/Curvature Function/CF/$D_0 – D_{200}$

Represents the shape of the deflection bowl between the maximum deflection and the deflection at an offset of 200 mm. It is used to estimate the likelihood of fatigue cracking of an asphalt pavement layer. The curvature of the deflection bowl is defined by the Curvature Function (CF) as follows:

$$CF = D_0 – D_{200}$$

where

D_0 = the maximum deflection

D_{200} = the deflection at an offset 200 mm from the point of maximum deflection.

A schematic view of the Curvature Function is shown in Figure 3.1.

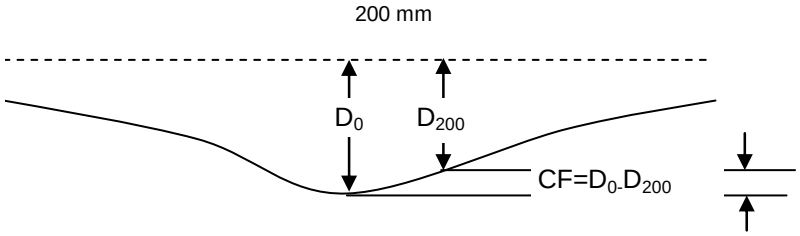

Figure 3.1: Schematic of Curvature Function (CF)

(e) Calibration

ISO (1993) defines 'calibration' as:

> [a] set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, of values represented by a material measure or a reference material, and the corresponding values realised by [measurement] standards.

(f) Validation

ISO (1994) defines 'validation' as:

> confirmation, through the provision of objective evidence that requirements for a specific intended use or application have been fulfilled.

4 EQUIPMENT

4.1 Vehicle Specification

A deflectograph consisting of the following:

(a) A single rear axle rigid truck (or similar vehicle) with dual wheels fitted to allow their free passage past the test arms as they move up to them. In order to be consistent with historical standards, use of radial tyres of type 1200 x 20 is common practice. The effects of using different tyre technologies and sizes needs to be carefully considered (refer 4.1(b)).

(b) A ballast of a known and evenly distributed load. A load of 8.2 ± 0.15 tonne on the rear axle has been adopted as a standard to provide consistency with the Equivalent Standard Axle (ESA) derived from analysis of the AASHO road test data collected in the 1950s. Other loads may be chosen for the following reasons:

- if the effect of a different, generally higher, load level is to be assessed
- where it has been unavoidable to use alternative tyre technologies or sizes, a Load Correction Factor is applied to allow conversion of values of deflection and curvature to those representing an 8.2 tonne load on standard tyres.

(c) The capability to travel at a constant speed up to 4 km/h for extended periods.

(d) The capability of mounting a guide frame, a winching system for the test frame and a test frame assembly with measuring arms each connected to a Linear Variable Differential Transducer (LVDT).

(e) A device, such as a shaft encoder or a distance rotopulse, to allow the precise measurement of the distance travelled during testing to an accuracy of ±1 m/km.

(f) A guide frame attached to the steering system of the truck that will align the tips of the measuring arms of the test frame, so as to allow the free passage of the passing wheels without touching the sides of the tyres.

(g) A winching system to cycle the test-frame forward after each measurement phase.

(h) A test-frame assembly of such durability, dimensions and geometry that will allow:

- sustained operation over long distances
- the tips of each measuring arm to pass through the corresponding set of rear dual wheels without touching the insides of the tyres
- the connection of the measuring arms to LVDTs of infinite resolution
- the entire test-frame unit to have an accuracy of ± 30 microns at the tip.

(i) Suitable instrumentation, signal conditioning and a data acquisition system capable of capturing and recording deflection values for each test bowl at between 3 m and 7 m intervals. The components of the system should conform to the manufacturer's specifications and be suitable for continuous use.

(j) Suitable warning devices necessary for traffic control.

4.2 Other Equipment

The following equipment is also required:

(a) The means of checking and maintaining a standard tyre to within ±20 kPa of the manufacturer's recommended value. A tyre pressure of 770±20 kPa (105-110 psi) is typically used.

(b) Temperature gauges with a minimum range of –5 °C to +100 °C, an accuracy of ±1 °C and capable of determining either ambient (air) and/or pavement temperatures at either the surface or a depth of 30 mm below the surface.

(c) If pavement temperature is to be measured, a hammer drill and tungsten bits to drill holes into the pavement structure, to a depth of 30 mm. A suitable oil needs to be placed in the hole to assist with pavement temperature measurement.

(d) Measuring wheel or tape to measure the offset of the device's testing wheels from the kerb or lane line to within ±0.1 m.

(e) Spray paint or other suitable equipment for pavement marking.

(f) Sufficient road location information to be able to relate the data collected to the client's road referencing system.

(g) Feature sheets and a supply of media to transfer data.

(h) Deflectograph manufacturer's User Manual.

5 CALIBRATION

(a) Calibration should be carried out in accordance with the manufacturer's User Manual.

(b) Calibrations should be carried out at least every 6 months or 500 lane-km of testing, whichever comes first.

(c) Additional calibrations must be carried out when any test system component likely to influence measurements is replaced, repaired or adjusted.

(d) An additional calibration must be carried out when damage could reasonably have been expected to have occurred, such as when the measurement arms are damaged.

6 PROCEDURE

6.1 Pre-test Set-up

6.1.1 Daily and Other Periodic System Checks

The daily pre-survey and other relevant periodic system checks listed in the manufacturer's User Manual must be followed prior to commencing survey work.

6.1.2 Traffic Control and Safety

(a) Traffic control shall be carried out in accordance with locally-applicable management procedures. These will have been based on AS 1742.3:2002.

(b) Appropriate judgement should be exercised so as to ensure the safe passage of traffic at all times.

6.2 Deflection Survey

(a) Determine the exact start and end points of the survey and also the number of lanes and direction of testing. If in doubt, check with the client and or the contract supervisor. Measure offset of outer wheelpath from kerb or lane line.

(b) The lane to be surveyed is called the 'test lane'. For routine network surveys, unless otherwise directed, the test lane shall be the lane that is used by the majority of the traffic. For most roads this coincides with the outer/slow/kerb lane.

(c) Testing shall not be carried out where there is excessive water on the pavement or where wet conditions will affect the safety of the operation.

(d) Make a visual check of all test components and check the rear tyre pressures and adjust to the standard pressure as necessary. As the tyre pressures will vary with changes in the heat of the tyres, it is important that pressure checks be conducted at operational tyre temperatures.

(e) Position the truck on the road so that the tip of the test beam is located approximately above the start chainage point of the road section to be tested. Definitively reference and record the starting point (and intermediate and ending points).

(f) Commence data acquisition in accordance with manufacturer's User Manual.

(g) Steer the truck so that the tips of the test arms are in the centre of the traversed wheelpaths. If it is not possible to track both wheelpaths simultaneously, the left hand arm (i.e. the one measuring the outer wheelpath) should be given preference, and a note made to that effect. Use of the steering wheel of the truck should be limited to the absolute minimum necessary to steer the vehicle during the measuring phase.

(h) If the pavement is known to contain asphalt, measure and record either the shaded air temperature or the pavement temperature, subject to safety and operational constraints.

(i) If pavement temperature is to be measured it shall be determined, and recorded against the appropriate chainage at the time of measurement, at either of the following locations:

- at a depth of 30 mm every hour using a temperature probe inserted into a 6 mm to 10 mm diameter oil-filled hole drilled into the pavement (stability of the temperature reading must be obtained before the temperature can be recorded: a minimum of 2 minutes waiting is required). Additional recording of temperature shall be carried out if a new road or section is tested within the hour
- at the pavement surface, at least every 5 minutes.

(j) During testing the vehicle should maintain a near constant speed, typically between 2 km/h and 4 km/h. Care should be taken when testing over any major surface irregularities such as bridge joints, rails, tram tracks, speed humps or major potholes. If it is suspected that traversing occurrences of such irregularities will result in damage to the test equipment, the obstacle must be avoided or the test frame lifted, and a new starting point used. Such actions shall be noted and recorded.

(k) Sudden transverse movements should be avoided and significant deviations from the test path are only permitted where the test lane is blocked, e.g. by a parked or broken-down vehicle. When such a manoeuvre is necessary, appropriate traffic control procedures should be exercised. Any deviation from the test lane must be noted and reported.

(l) Testing shall be terminated if continuation is likely to cause damage to the test assembly or vehicle.

(m) Testing should be terminated by stopping the data acquisition system at the end of a measuring cycle. The end point of the test should be recorded, to the nearest metre.

(n) Make copies of the resultant test files on separate media, typically a 'working copy' and a 'backup copy'. As soon as possible after returning from the field, process and/or archive both data copies.

7 REPORTING

The data to be collected, but not necessarily reported, for each survey must include the following:

(a) date/time of testing

(b) known test axle load to the nearest 0.1 tonne

(c) tyre pressure of the test axle tyres

(d) location of the pavement road/section with regard to the client-specified location reference system, including start and end chainages of survey test runs, and locations of any reference or control points within the survey

(e) test lane and direction of survey

(f) deflection bowls measured and the chainages at which they were measured – as a minimum, maximum deflection and the curvature function must be reported

(g) ambient air temperature, reported to, at least, the nearest 1 °C (if measured)

(h) pavement surface temperature, reported to, at least, the nearest 1 °C (if measured)

(i) pavement temperature at 30 mm depth, reported to, at least, the nearest 1 °C (if measured)

(j) error or event flags and operator comments where applicable.

AMENDMENT RECORD

Amendment No.	Sections amended	Action [1]	Date
1 (Initial release)	All (Graham Foley, Graham Foley & Associates & Michael Moffatt, ARRB)	New	26 March 2007
2 (Revised release)	All (Richard Wix, ARRB, project AT1484)	Substitution	2 March 2011

[1] Key:

Format	change in format
Substitution	old section removed and replaced with new section
New	insertion of new section
Removed	old section removed